RESEARCH HIGHLIGHT

Revision November 2004

Technical Series 04-129

DURABLE WOOD-FRAME CONSTRUCTION FOR ALL CLIMATIC ZONES: A COMPANION TO CANADIAN WOOD-FRAME HOUSE CONSTRUCTION

INTRODUCTION

Wood-frame construction, which is well developed and accepted in North America, is beginning to be exported—thanks, in large part, to the efforts of Canadian designers, builders and suppliers—to climatic zones where it has been little used.

It is essential for the long-term viability of wood-frame construction in new markets that it proves to be durable. Canada Mortgage and Housing Corporation (CMHC) commissioned *Durable wood-frame construction for all climatic zones: A companion to Canadian wood-frame house construction* to supplement *Canadian wood-frame house construction*, CMHC's popular reference book. The intent is to support Canadian builders, designers and suppliers in offshore markets and at home.

Part I of the three-part *Durable wood-frame construction for all climatic zones* deals with well-established building science principles for building envelope durability.

Part II breaks new ground, with methods allowing a designer or builder to select a particular wall construction based on local site conditions. The local conditions are based on climatic data from a weather database on NASA's (U.S. National Aeronautics and Space Administration) website

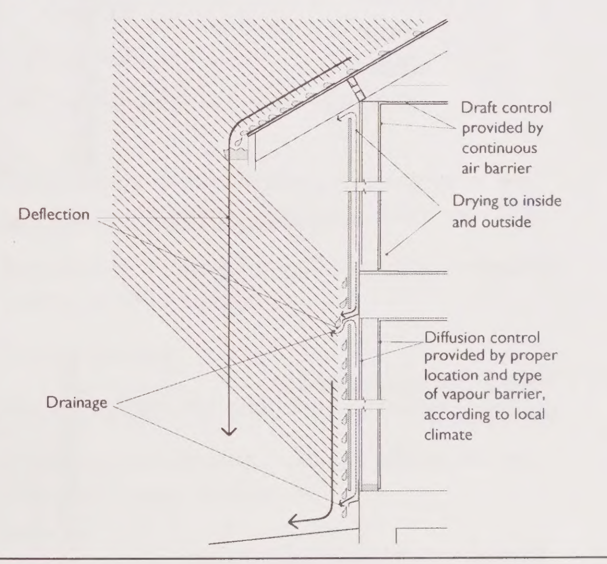
Part III gives examples of durable wood-frame building assemblies for the world's climate zones.

Below are point-form summaries and sample illustrations from Parts I, II and III of *Durable wood-frame construction for all climatic zones*.

PART I

- The building science principles of building envelope durability.
- The 5 Ds of moisture control, deflection, drainage, draft control, drying ability and diffusion control.
- Concealed barrier, drainscreen and rainscreen exterior wall cladding systems.
- Air barrier systems.
- Vapour barrier types and their locations with building assemblies.
- Durable foundation construction for both moisture control and termite prevention.
- Whole-house natural and mechanical ventilation for cooling and indoor air quality.

Figure 1-The 5 Ds of moisture control



CMHC SCHL

HOME TO CANADIANS

Canada

Figure 2-Examples of drying in different wood-frame wall assemblies

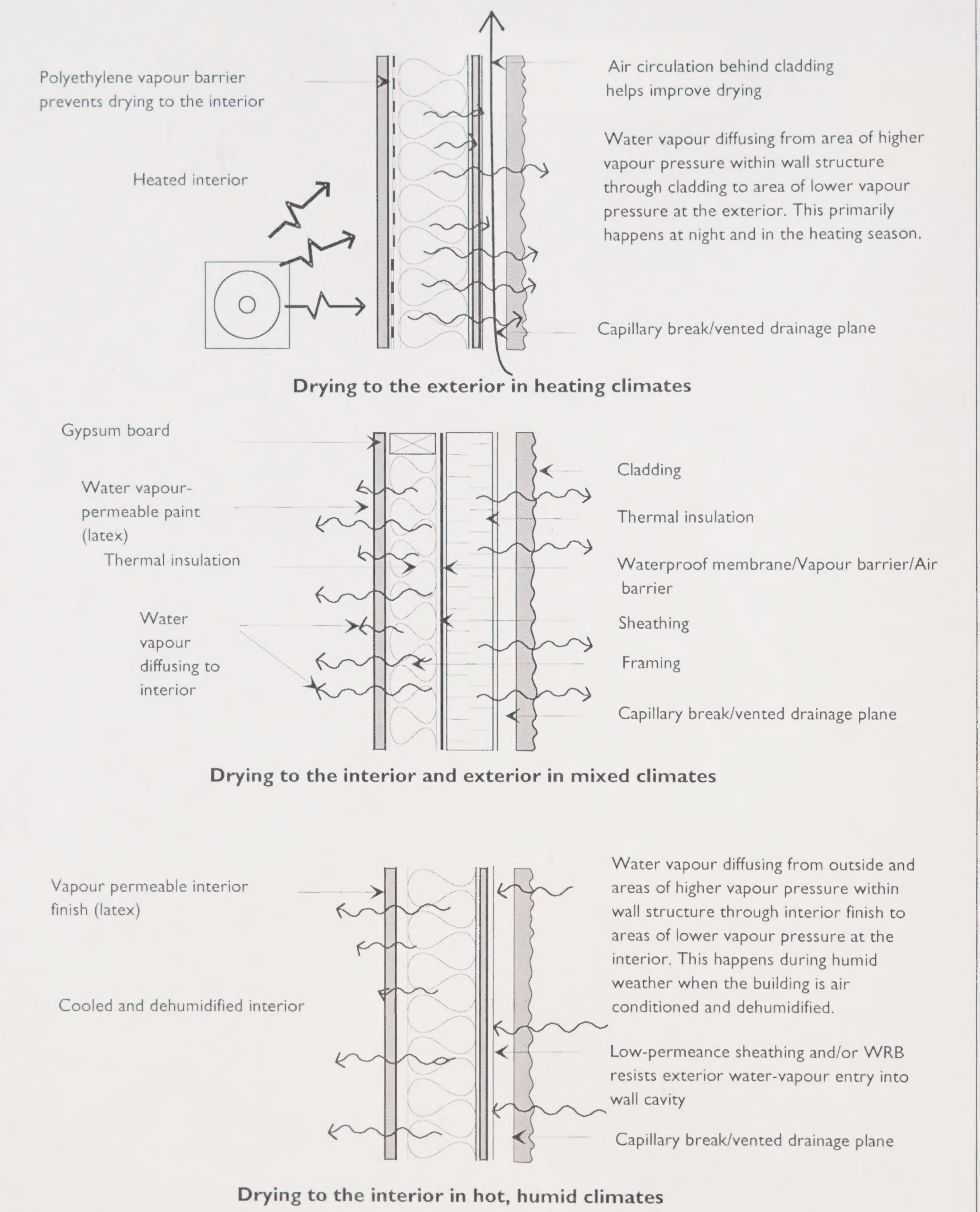
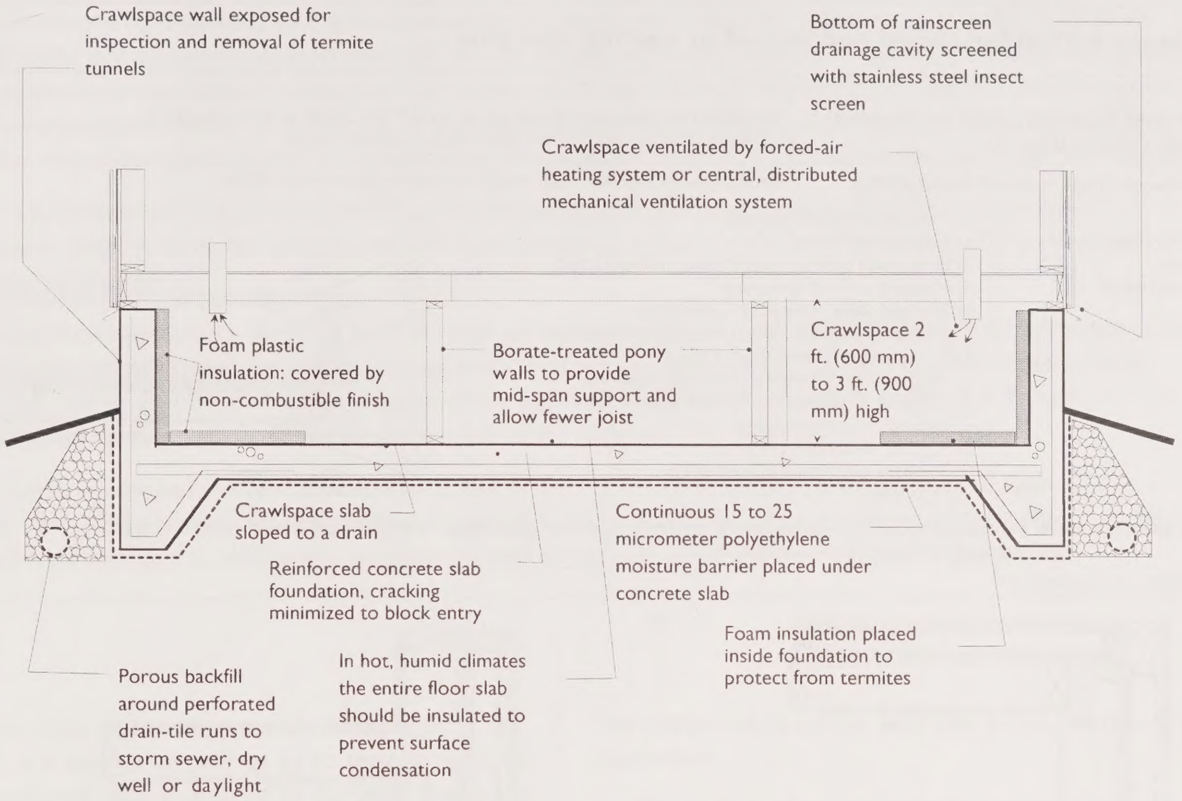


Figure 3-Crawlspace foundation for warm and hot climates is heated, cooled and ventilated in the same manner as the rest of the house. In hot, humid climates, the entire floor slab may need insulation to prevent condensation formation.



PART II

- A method for identifying the climatic zone of every one-degree of latitude and longitude of the earth's surface. Once the user knows a site's latitude and longitude, the user can find the site's climatic zone. This method uses a free database on a NASA website with climatic information from satellites and ground-based stations.
- Information other than climate zone information that designers might find useful.
- Categorization of climates for design in North America.
- Examples of categorizing climates in different parts of the world using the same approach.
- Definitions of climatic zones.
- Classification of rain-wind climatic factors ("Environmental Climatic Index"—ECI).
- Determining rain and moisture tolerance of wall assemblies ("Moisture Tolerance Index" or MTI).
- Required MTI values for walls exposed to specific rain-wind ECI conditions.
- Placing barriers.
- Climatic effects not addressed by building codes.
- Modifying conventional building systems for use in a wider range of climates.

PART III

- Descriptions and illustrations of sample building assemblies for the climatic zones defined in Part II.

The following is a sample building assembly for one climatic zone, with an accompanying graphic.

WALL FOR MIXED AND HUMID, OR MARINE CLIMATES

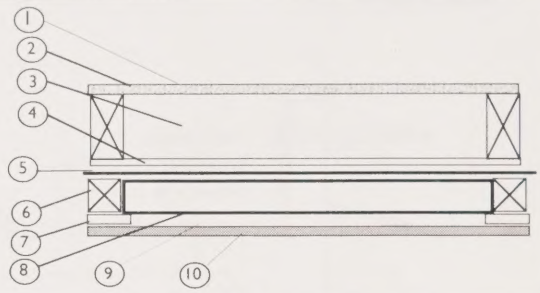
Figure 4 is a cross-section of an exterior wall and details at the intermediate floor, at the roof and at the foundation for a wood-frame wall built with 2x4 (38x89 mm) or 2x6 (38x140 mm) framing.

Figure 4-Wall for mixed and humid or marine climates

Platform frame 2x4 (38x89 mm) Inverted wall, Peel-and-Stick AVB	Wood-Frame structure: Studs @ 16" or 24" O.C (400 to 600 mm O.C) Cladding: Stucco, wood, vinyl, fiber cement board, metal
Climate(s): marine, mixed humid (MMH)	Components: Exterior wall, roof, foundation, intermediate floor

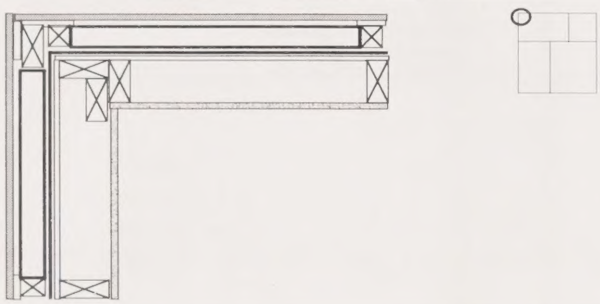
Overview and comments

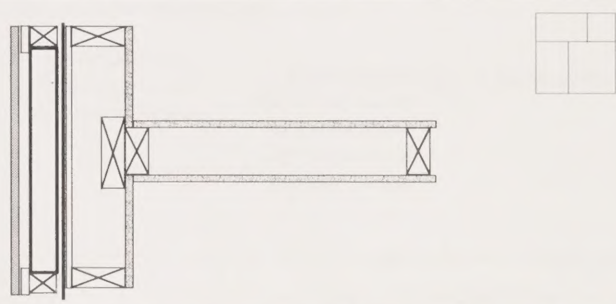
1) Vapour-permeable coating
2) Gypsum wall board
3) Empty wall cavity for mechanical and electrical
4) Plywood or OSB sheathing
5) Peel-and-stick waterproof membrane air barrier, vapour barrier and moisture barrier
6) Preservative-treated shear blocks for seismic areas or where insulation requires
7) 3/8" to 3/4" (10 mm to 19 mm) preservative-treated vertical strapping
8) Rigid or semi-rigid insulation
9) Drainage and ventilation air space
10) Cladding

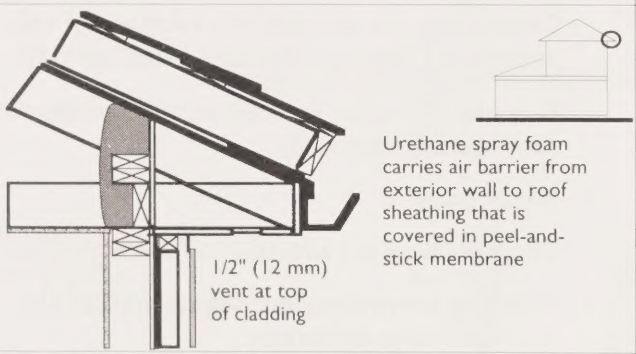


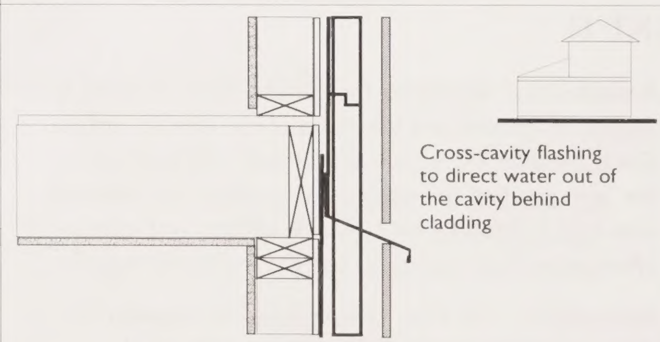
Insulation options: Extruded polystyrene, expanded polystyrene, rigid fiber glass board, mineral wool board, spray urethane foil-faced urethane foam board, EPS

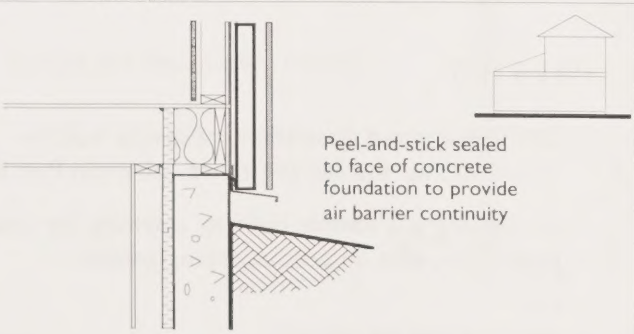
Notes on construction

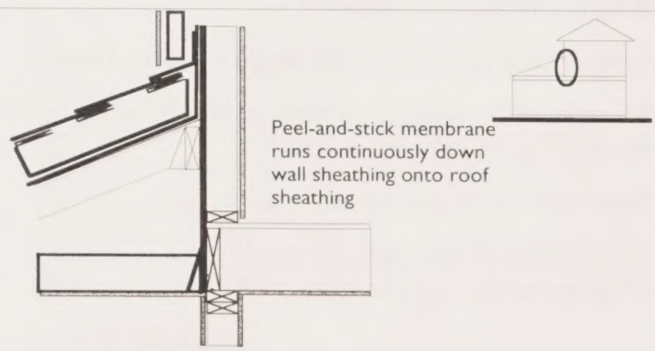












The paint layer (1) on drywall (2) has a vapour permeance between 5 and 10 perms (or 280-570 ng/m²sPa). A primer sealer and a finish coat of latex paint achieve this level of water vapour retardation. The wood-frame cavity (3) is either left unfilled or a thin layer, as a rule less than 1-in. (25 mm) thick, continuous layer of spray polyurethane foam provides an internal air barrier. An impermeable membrane (5) is typically sandwiched between the OSB or plywood sheathing (4) and the exterior thermal insulation (8) to provide the required degree of air and moisture control. This membrane functions as the air barrier, vapour retarder and moisture barrier.

Typically, the membrane (5) is peel-and-stick, with water-vapour permeance lower than that of the paint, that is, 0.2 to 0.6 perm (12 to 35 ng/m²sPa) and air permeance lower than 0.02 l/m²sPa. The exterior thermal insulation is typically either extruded polystyrene, faced polyisocyanurate or spray-applied medium (or high) density polyurethane foam. In this system, the thermal insulation must be resistant to water penetration either by its nature or be provided with water-impermeable facing. It has to provide a drainage plane and protection from reverse moisture drive, that is, moisture driven from a porous, rain-soaked cladding into the wall by the solar radiation.

The ⅜ in. to ¾ in. (10 mm to 19 mm) thick preservative-treated furring strips (7) are oriented vertically and secured with corrosion-resistant fasteners. In seismic locations and with heavier cladding, vertical preservative-treated shear blocks are used; refer to a structural engineer.

A critical part of rainscreen design is the provision of drainage and venting space (9) at the top of the wall and at intermediate floors or foundation. At the top of the wall, the designer typically provides a ½-in. (12 mm) gap between the top of the cladding and the underside of the soffit to allow for venting. At the bottom of the wall and at intermediate floors, the cladding is vented and flashed to direct any water from the space to the outside. Screened mesh is incorporated at all vents to keep insects out.

All window and door heads and mechanical penetrations must be flashed with flashing that extends up 4 in. (100 mm) behind the sheathing membrane, past through the drainage cavity and out 1 in. (25 mm) beyond the face of the cladding. Roof overhangs extending out a minimum of 2 ft. (600 mm) also protect the wall immediately below and should be used where possible.

Figure 4 shows that the same general principles of construction are applied to ceilings as to the wall system. A sheet of peel-and-stick is applied to the roof sheathing, forming the air barrier with the rigid foam insulation applied over that. The attic space is sealed from the outside, using spray urethane foam. This makes the attic space part of the conditioned volume of the building. Only the soffit is vented to the outside. This approach also has the advantage of allowing ductwork to be run in indoor conditions in the attic space, reducing heat losses and gains through the ductwork.

IMPLICATIONS

Building wood-framed construction in various climates has largely been done with little modification in Canada and other parts of North America except for satisfying thermal requirements. This has led to some inappropriate installations and poorer durability, particularly in hot, humid climates. *Durable wood-frame construction for all climatic zones* provides a framework around which different climatic zones can be identified in North America and the world and suggests a range of specific systems for each construction zone.

The document is set up with this prime, common-sense imperative:

> The priority for dealing with moisture is to ensure that the major sources are addressed first in design. This means providing moisture control in the following order-rain control, air-leakage control and, finally, vapour-diffusion control.
>
> The second imperative is that every house is a system, and many things affect its performance. The builder needs to consider how roofs, foundations and heating-cooling-ventilation systems—all needed for occupant comfort—interact.

While the general knowledge in *Durable wood-frame construction for all climatic zones* can be applied to construction in North America, it also applies to other parts of the world where wood-framed construction can provide affordable, energy efficient and safe housing. Builders should also always be sensitive to cultural differences in how people use their living spaces. Building codes in other countries as well of local knowledge about materials and the climate should also be factored in to produce appropriate designs in these other jurisdictions.

CMHC Project Manager: Don Fugler

Consultant: Enermodal Engineering Limited, Kitchener, Ont.

Housing Research at CMHC

Under Part IX of the *National Housing Act*, the Government of Canada provides funds to CMHC to conduct research into the social, economic and technical aspects of housing and related fields, and to undertake the publishing and distribution of the results of this research.

This fact sheet is one of a series intended to inform you of the nature and scope of CMHC's research.

To find more *Research Highlights* plus a wide variety of information products, visit our website at

www.cmhc.ca

or contact:

Canada Mortgage and Housing Corporation
700 Montreal Road
Ottawa, Ontario
K1A 0P7

Phone: 1 800 668-2642
Fax: 1 800 245-9274

OUR WEB SITE ADDRESS: www.cmhc.ca

63735